Memorandum

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Subject: *Summary of CDM Smith Modeling Work in the PVOU, including in the Vicinity of the Former Benchmark Site*

CDM Smith understands that USEPA has requested a description of any and all modeling efforts associated with the former Benchmark facility, including when CDM Smith was provided with the DSI-related onsite CPT data, and if/how such data were incorporated into our groundwater model. The requested information is provided in the text below.

Summary of CDM Smith Modeling in the PVOU

Detailed numerical groundwater flow and transport modeling focusing on the Benchmark source area or immediate offsite area south of Puente Creek has not been performed by CDM Smith to date. The only numerical model that incorporates Benchmark site data is the regional groundwater model (CDM Smith model) constructed in support of the PVOU Intermediate Zone (IZ) Remedy. This regional groundwater model was applied to provide guidance to Northrop Grumman on the drilling of a network of IZ monitoring wells used to delineate the lateral and vertical extent of contamination in PVOU. Later, it was used to locate extraction wells for the IZ Remedy and provide associated remedy design support, support with the establishment of regional performance criteria, support for negotiations with San Gabriel Valley Water Company regarding the planned locations and pumping rates of their B7 well field production wells, etc.

Among other applications of the CDM Smith model performed at Northrop Grumman's request, the regional model was also used in the 2003/04 time period to estimate the range of groundwater levels expected in the Valley Boulevard vicinity, accounting for climate variation, regional water supply pumping, and estimated regional and site remedial pumping. The model was also used to estimate the benefit of potential Benchmark site remedial pumping at Valley Boulevard, assuming "adequate capture" of site contamination, on the regional shallow zone and IZ Remedy. This work was done to assist Northrop Grumman in its negotiations with RWQCB and

USEPA for an expanded groundwater remediation effort for the plume coming from Northrop Grumman's Benchmark facility. The numerical piezometric modeling was conducted concurrent with analytical modeling (e.g., Theis-type analyses) performed by Orion Environmental.

The need for additional, focused modeling work south of Puente Creek incorporating detailed hydrostratigraphy in the Shallow Zone (SZ) has been discussed with Northrop Grumman and USEPA but has not yet been initiated. Further refinements to the model are anticipated to occur once the additional data are collected for the Puente Creek South remedy.

Additional Background – Development of the Regional IZ Model

CDM Smith performed regional groundwater flow and transport modeling from the mid- to late-1990s for the Puente Valley Steering Committee, and later for TRW (now Northrop Grumman Corporation) in support of PVOU IZ Remedy as described in more detail in the March 14, 2008 Groundwater Modeling Report for the IZ Remedy, Appendix C of the Compliance/General Monitoring Plan for the IZ Remedy (CDM 2008). In the 2003-2004 timeframe, CDM Smith was essentially working in parallel with USEPA's consultant who was working on the development of a numerical groundwater model using the FEFLOW model code in support of the design of the SZ Remedy. During this period, CDM Smith and USEPA's consultant exchanged groundwater flow model files on several occasions, held technical meetings to discuss modeling efforts, and were working together to ensure consistency between the USEPA model and the CDM Smith model representations of the aquifers in the PVOU. At that time, CDM Smith essentially adopted the hydrostratigraphic representation for the top four levels of the CDM Smith model from USEPA's contractor. The bulk of the basic groundwater model development by CDM Smith was completed by the end of the 2003-2004 time period.

Transport modeling was performed to simulate the development of regional VOC (PCE, TCE, 1,1-DCE, and 1,4-Dioxane) plumes in PVOU groundwater from multiple known or suspected source areas of these contaminants throughout the OU. The principal objectives of transport model development were:

1. To help delineate the lateral and vertical extent of contamination within PVOU,

2. To simulate contaminant transport in response to hydraulic stresses on the aquifer caused by variations in production well pumping (important for the IZ) and major basin-wide variations in water levels, and

3. To simulate contaminant migration from a variety of known and suspected source areas within the historical flow field such that the simulated VOC plumes reasonably matched observed water quality data in the network of regional groundwater monitoring wells and reasonably matched VOC mass removed at the production wells in the B7 well field.

Between 2005-2007, the extraction wells for the SZ Remedy and IZ Remedy were installed by the work parties, and additional data became available as a result of the drilling, well installation, and aquifer performance tests performed as part of these efforts. The CDM Smith model was updated to incorporate this information and the period of the transient simulation was extended from October 2003 to October 2006. Specifically, the layer thickness of some model layers was adjusted and hydraulic conductivity values were modified in the layers representing what is now called the Upper Intermediate Zone (MZ) and the Lower Intermediate Zone (IZ). The model was documented in the Groundwater Modeling Report (CDM Smith 2008) at this point in its development.

In late 2010 or early 2011, the period of the transient simulation was extended to October 2009 in response to a request from USEPA.

Numerical Model Applications

CDM Smith has used the numerical groundwater flow and contaminant transport components of the model in numerous applications for Northrop Grumman. The principal purpose of the model was to assist in the design of the IZ Remedy extraction system, namely to identify appropriate extraction well locations and depths to meet the objectives of the Interim Record of Decision (ROD) and Explanation of Significant Differences (ESD). The model is also to be used as a tool to help evaluate compliance. The model has also been used in numerous applications to help understand and interpret field data. In other examples, the model was used to evaluate proposed modifications of pumping at the San Gabriel Valley Water Company B7 well field, and to estimate the range of water levels expected at Valley Boulevard and the potential benefits to the regional remedy of remedial pumping at Valley Boulevard as noted above.

Simulation of a Source at the Former Benchmark Facility

As documented in the Groundwater Modeling Report (CDM 2008), a source area was simulated, as one of many known or suspected source areas within the PVOU, at the former Benchmark facility in CDM Smith's PVOU regional model. Regional model source terms (or loading rates) were assigned to represent the rate of down-gradient transport of contamination from the source area. The best indicator of transport from a source area is measured concentrations in down-gradient wells. Measured source area concentrations are often not indicative of down-gradient transport potential because the concentrations may be measured in relatively impermeable soils or soil zones that are relatively isolated from the main pathways of groundwater flow. During calibration, regional model source terms were, therefore, adjusted for the various source areas represented in the model, including Benchmark, until a reasonable match was achieved between the simulated and observed water quality in the groundwater monitoring well network near the simulated source areas, and until the resultant plumes of contamination reasonably matched the lateral and vertical extent of contamination observed in the regional network of monitoring wells.

The source area at Benchmark was simulated as a simple line source at the water table, constant for the entire simulation. This representation of the contaminant source at the former Benchmark

facility is general in nature, and is appropriate for regional-scale modeling. CDM Smith was provided with the Benchmark DSI CPT data in 2004. These data were reviewed to (a) identify any inconsistencies with the stratigraphy represented in the PVOU model, and (b) assess whether the soil chemistry data were relatively consistent with the source term estimated by approach described above. As noted above, CDM Smith's PVOU modeling has always assumed that the Benchmark facility is a continuing source of contaminants to groundwater, owing to the technical infeasibility of removing all mass from the fine-grained portions of both the unsaturated and saturated zones on the property. No inconsistencies with the stratigraphy or the represented source terms were identified; as a result, no modifications were made to the regional model in light of these CPT data.

Three-dimensional Representation of the Benchmark Plume and 2-D Animations of Plume Migration

Beginning in December 2010 and in preparation for the February 10, 2011 meeting with USEPA, CDM Smith imported stratigraphic layers as represented in the IZ regional groundwater model into a data visualization tool and generated 3-D graphical presentations to present to USEPA. This was not numerical modeling but an interactive data display. These graphics, which can be manipulated by the viewer for inspection in three dimensions, were generated using EVS/MVS data software package (http://www.ctech.com/) and illustrated water quality data in the network of Benchmark site wells and regional network of PVOU extraction wells and monitoring wells. The graphics also incorporated output from the regional CDM Smith numerical transport model.

Additional two-dimensional animations were shown at the meeting. These showed the development of plume contours from the regional model source area at the former Benchmark facility and the movement of the simulated contaminant plume in response to regional aquifer stresses over time. These animations were visual depictions of simulation results from the CDM Smith model. These graphics were presented to USEPA at the February 2011 meeting. Copies of the graphics were not requested by USEPA, CH2MHILL, or DTSC at the meeting. These graphics are available to USEPA, upon request and can be viewed using a free downloadable viewer.